(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 July 2003 (31.07.2003)

PCT

(10) International Publication Number
WO 03/062528 A1

(51) International Patent Classification[7]: D21F 3/00, 11/00, F26B 13/06

(21) International Application Number: PCT/US03/02108

(22) International Filing Date: 24 January 2003 (24.01.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/056,489 24 January 2002 (24.01.2002) US

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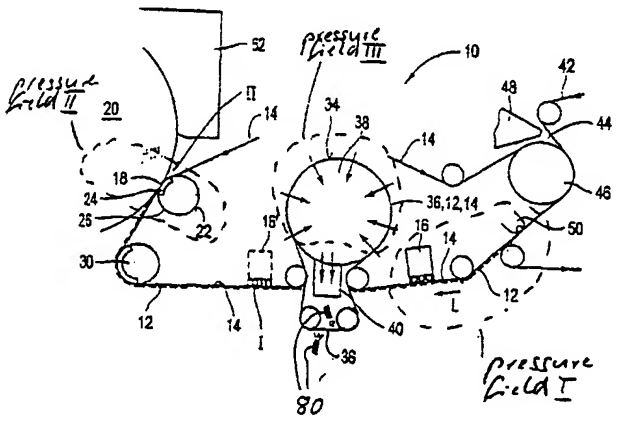
(81) Designated States *(national)*: BR, CA, JP, US.

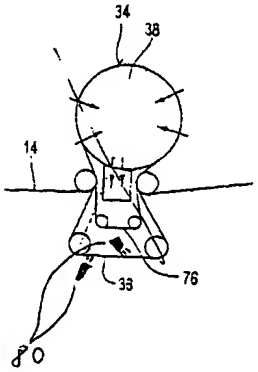
(84) Designated States *(regional)*: European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI, SK, TR).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

[Continued on next page]

(54) Title: MANUFACTURING THREE DIMENSIONAL SURFACE STRUCTURE WEB





(57) Abstract: In a method for manufacturing a fiber web (12), in particular a web of tissue or hygiene material, provided with a three dimensional surface structure, the fiber web is pressed at a dry content of less than 35%, in particular less than 30%, and preferably less than 25% onto an imprinting fabric (14) by a first pressure field and is thereby pre-imprinted, and in which the fiber web is guided through at east one pressure field (third pressure field) provided for dewatering and or drying said fiber web. Preferably, the fiber web is once more pressed onto an imprinting fabric by means of a second pressure field in order to fix strength without destroying the three dimensional surface structure. The fiber web is preferably guided between the first and the second pressure field through said at least one third pressure field. Preferably, the same imprinting fabric is used in said first pressure field and said second pressure field. Moreover, the dry content is achieved by a favorably priced apparatus instead of by TAD drying apparatus.

WO 03/062528 A1

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

MANUFACTURING THREE DIMENSIONAL SURFACE STRUCTURE WEB

The invention relates to a method and to an apparatus for manufacturing a fiber web, in particular a web of tissue or hygiene material, provided with a three-dimensional surface structure. It further relates to a method and an apparatus for dewatering a fiber web, in particular a web of tissue or hygiene material.

The imprinting of a three-dimensional structure into the surface of a paper web, in particular of a tissue web, in particular of hand tissue, is known (see, for example, WO 99/47749, WO 01/18307). It is further known that a very good paper quality can be achieved by a so-called through-air drying (TAD) process. However, it is disadvantageous that the use of TAD dryers is very complex and correspondingly expensive to purchase and operate.

To make the highest quality tissue and toweling products, it is necessary to develop products that are high in bulk, high in absorbancy, yet still have adequate strength. The normal papermaking processes, which includes shoe and roll presses for dewatering a wet sheet, do not provide a bulky, absorbant sheet. Instead, they provide a strong, "flat" sheet that is typical of old technology low cost tissue.

Several techniques are used to develop sheet bulk. Generally, the fiber web or sheet is first formed on or vacuumed into a special embossing or imprinting fabric. This fabric is rough, due to its coarse weave. The wet sheet conforms to this fabric, and in doing so this increases the overall

bulk of the sheet. Next, air is pulled through the sheet using vacuum, or low pressure. This airflow mechanically dewaters the sheet. Finally, hot air is blown through the sheet to dry it. The hot air dryer is called a Through Air Dryer (TAD for short). A TAD is usually made up of two large drums that are under vacuum that pull heated air through the sheet drying it. These are very expensive units costing 10's of millions, to install.

As shown in earlier times, one way to get high bulk is to emboss (mold) the sheet while it is wet. This can be done either by forming the sheet on a rough forming (or molding) fabric, or it can be formed "flat" in a conventional manor and then it can be vacuumed into a embossing fabric. Either way, the sheet surface takes on the approximate shape of the embossing fabric surface. After the sheet is molded, it must be dried to its final state. Drying is usually a two step process, where water is first removed mechanically, and then the remaining water is removed using heat.

The problem is that it is difficult to mechanically remove water from the sheet without destroying its molded structure. If the sheet and fabric are pressed for example, little water is removed since the embossing fabric adsorbs and then rewets the sheet after pressing. If the sheet is removed from the embossing fabric and then pressed, more water is removed, but the sheet bulk and adsorbancy is lost since the sheet becomes flatter.

The situation is slightly better if the sheet and embossing fabric are passed over a vacuum box. In this case, most prior art shows that the embossing fabric is on the vacuum side, supporting the sheet as air is pulled through it. The action of the vacuum removes water from the sheet, but after the water leaves the sheet, the embossing fabric retains much of it. Later, when the vacuum is removed, water passes back into the sheet, rewetting it. With this technology, the highest solids obtained for the sheet

with low basis weights is less than 25 % and more likely close to 20 %. Never the less, vacuum dewatering has been used since it retains the sheet structure. However because the sheet is so wet, this technology uses a lot of energy, in the form of a hot air, to dry the sheet.

It is an aim of the invention to provide an improved method and an improved apparatus of the kind initially mentioned with which in particular a high quality of the end product can be achieved in an economic and correspondingly favorably priced manner even without the use of a larger TAD drying apparatus. In this connection, a corresponding quality should be reached in particular with respect to the water retention capacity, the water absorption rate, the bulk, softness, etc.

This object is satisfied in accordance with the invention by a method for manufacturing a fiber web, in particular a web of tissue or hygiene material, provided with a three-dimensional surface structure, in which the fiber web is pressed, e.g. sucked, at a dry content of <35%, in particular <30%, and preferably <25% onto an imprinting fabric by means of a first pressure field, and is thereby pre-imprinted, and in which the fiber web is guided through at least one pressure field (third pressure field) provided for dewatering and/or drying said fiber web.

As a result of this embodiment, a lasting three-dimensional surface structure is produced in the relevant fiber web, i.e. in particular in the relevant paper web, tissue web, or hygiene paper web, which is also present in the desired manner in the web, i.e. for example in the paper, even after the drying process. The use of a complex and correspondingly expensive TAD process is no longer required. In particular a lasting surface structure of, for example, of a tissue web or of a hygiene paper web can now also be

produced downstream of the forming region or forming zone even without such a TAD drying apparatus.

Preferably, the fiber web is once more pressed onto an imprinting fabric by means of a second pressure field in order to fix strength without destroying the three-dimensional surface structure. The fiber web is preferably guided between the first and the second pressure field through said at least one third pressure filed. Preferably, the same imprinting fabric is used in said first pressure field and said second pressure field.

The imprinting or structured fabric could be a woven or a casted fabric in a continous loop and can, for example, be a TAD (through-air-drying) fabric or an imprinting membrane.

The fiber web is generally pre-imprinted downstream of the forming region.

It is of advantage in certain cases for the fiber web to be formed on the imprinting fabric used for the pre-imprinting. The fiber web can, however, also be transferred onto the imprinting fabric used for the pre-imprinting.

In accordance with a preferred embodiment, at least the first pressure field is produced by means of at least one suction or pressure element arranged on the side of the imprinting fabric remote from the fiber web in order to suck or press the fiber web into the surface structure of the imprinting fabric. In this connection, in particular a so-called wet suction box or pressure box can be used as the suction or pressure element.

It is also of advantage for the fiber web to be pressed gently in the second pressure field, i.e. preferably over an extended nip in the web running direction.

The second pressure field is preferably produced by means of a press nip. To effect the most gentle possible pressing of the web, this press nip can, for example, be produced between a dryer cylinder and an opposing element, with the fiber web guided through the press nip being in contact with the surface of the dryer cylinder and contacting the imprinting fabric with its other side. In particular a so-called Yankee cylinder can be used as the dryer cylinder. In particular a shoe press unit, which includes a flexible sleeve guided via a press shoe in the region of the press nip, can be used as an opposing element interacting with the dryer cylinder, with a shoe pressing roll provided with a flexible roll sleeve preferably being used as the shoe press unit. However, a press roll or a suction pressing roll can, for example, also be used as an opposing element interacting with the dryer cylinder.

A preferred practical embodiment of the method in accordance with the invention is characterized in that the pre-imprinted fiber web is dried on the dryer cylinder, or the Yankee cylinder, the fiber web is creped and/or the fiber web is subsequently wound up.

In accordance with a preferred embodiment of the method in accordance with the invention, the dry content at which the fiber web is pre-imprinted and/or the dry content at which the three-dimensional surface structure is created is selected in each case at <30%, in particular <25%, in particular <15%, and preferably <10%. The water retention capacity and the bulk, among other things, are thus lastingly increased, which means that the desired imprinting is also still present on the use of the end product,

for example of a relevant web of tissue or hygiene material. In particular the advantage of a higher water retention capacity for towel tissue (towel paper) is also still effective on the use of the relevant end product.

The third pressure field is preferably provided between said first pressure field and said second pressure field.

In accordance with a preferred practical embodiment of the method of the invention, a drying apparatus is used in order to provide said third pressure field.

In accordance with a preferred practical embodiment of the method of the invention, a suction or pressure device is used as a drying apparatus. The fiber web can, for example, be guided together with an imprinting fabric both through the third pressure field and the second pressure field. It is of advantage in this connection if the suction or pressure device has a curved surface and if the fiber web and the imprinting fabric are guided over this curved surface.

A suction roll can, for example, be used as the suction device. Such a suction device can have a pressurized hood to support the vacuum effect of the suction device.

According to another preferred practical embodiment of the method of the invention said third pressure field is provided by a gas press, preferably an air press. Such an gas or air press can, for example, comprise an arrangement of at least four rolls or a U-shaped box.

In addition it is advantageous to operate the gas or air press for displacement dewatering with a pressure in the chamber of > 30 psi, preferably > 40 psi.

In general, one or more third pressure fields can be provided. The third pressure fields can, e.g. be provided by drying apparatus of a different kind. For example, one of the drying apparatus can comprise a gas or air press whereas another drying apparatus may comprise a suction roll or the like.

Further advantages result in the use of a press shoe due to the relatively long press nip, since a better transfer of the fiber web to the Yankee cylinder is achieved over a longer nip providing a longer dwell time.

The imprinting fabric can in particular be guided via the suction element or the wet suction box upstream of the suction device, i.e. for example the suction roll, in order to suck the fiber web into the three-dimensional surface structure of the imprinting fabric and thus to imprint this structure onto the imprinting fabric. At the same time, the relevant suction element results in a corresponding increase in the dry content.

It is also of advantage for the length of the press nip of the shoe press including the dryer cylinder and the shoe press unit observed in the web running direction to be selected larger than a value of approximately 80 mm and for the shoe press to be designed such that a pressure profile results over the press nip length with a maximum pressing pressure which is smaller or equal to a value of approximately 2.5 MPa. A gentle pressing is thus ensured with which it is avoided that the structure produced in the fiber web, e.g. in the tissue web or in the hygiene paper web, is again smoothed out.

As already mentioned, a suction roll, with which a pressure hood is preferably associated, can, for example, be used between the suction element producing the first pressure field and the press nip.

In accordance with a preferred practical embodiment of the method in accordance with the invention, at least one dewatering fabric with zonally different fabric permeability is used in the forming region. The relevant dewatering fabric can in particular be provided as an outer fabric. A corresponding embodiment of the method is in particular of advantage in the manufacture of towel tissue. The fabric produces a fine structure which increases the water absorbing rate and which provides an increased water retention capacity in conjunction with the imprinting in accordance with the invention.

In certain cases, it is of advantage if a former with two circulating dewatering fabrics is used, e.g. twin wire former, which run together to form a pulp run in gap and are guided over a forming element such as in particular a forming roll, and if a dewatering fabric with zonally different fabric permeability is used as an outer fabric not coming into contact with the forming element and/or as an inner fabric. In this connection, an imprinting fabric can be used as an inner fabric, for example, and preferably a dewatering fabric with zonally different fabric permeability as an outer fabric. It is, for example, also possible for the fiber web preferably to be transferred from the inner fabric to an imprinting fabric.

In wet imprinting in a tissue machine provided with an imprinting fabric, it is in particular a question of achieving the desired dry content. The web can, for example, be wet imprinted by means of the imprinting fabric using a suction box upstream of the press.

To now avoid the three-dimensional surface structure, which was pre-imprinted by the wet imprinting in the region of the wet suction box, being destroyed again by a short-term high pressure in the press nip in cooperation with a press felt, as is the case e.g. with a conventional suction press roll or press roll, in accordance with an advantageous practical embodiment of the method in accordance with the invention, there is guided through the press nip the imprinting fabric, e.g. a TAD fabric or an imprinting membrane, which is structured such that a smaller contact area portion formed by raised or closed zones (solid portions between the holes) results for this imprinting fabric in comparison with the non-contact area portion formed by recessed zones or holes and accordingly a smaller contact area portion of the fiber web is pressed in the press nip. The smaller contact area portion of raised or closed zones produces the web regions of high density for the strength, whereas the larger surface portion of recessed zones or holes, which remains at least substantially unpressed, provides the desired water absorption capacity and the desired bulk such as has previously only been achieved by a complex and expensive TAD drying.

In this connection, an imprinting fabric can advantageously be used in which the contact area portion of raised or closed zones is $\leq$40% and preferably lies in a range from approximately 20 to approximately 30%, and in particular at approximately 25%. The contact area need not to be the same as the open area or the void volume. The open area or the void volume of a fabric can be independent of the contact area.

An imprinting fabric is expediently used in which the raised zones and the recessed zones result through offsets, i.e. through intersections of picks and ends, of a fabric cloth. As already mentioned, an imprinting mem-

brane can, for example, also be used in which the raised and recessed zones result through the holes. It is of advantage in this case that 100% of the surface is pressed around the holes and a higher strength results.

The relevant imprinting fabric can again be guided together with the fiber web, for example, over a dryer cylinder, in particular a Yankee cylinder. In particular a shoe-pressing unit can again be used as the opposing element interacting with the dryer cylinder. The length of the press nip observed in the web running direction and the pressure profile resulting over the press nip length can also in particular be again selected such as was set down above.

It has been found that with the method in accordance with the invention, a water absorbing capacity (g H_2O/g fibers) higher by at least 50% and a bulk (cm^3/g) higher by 100% can be achieved with the same tensile strength when an imprinting fabric is used instead of a conventional felt in the press nip.

The quality of the paper results as a consequence of the lower pressing of the web as a consequence of the smaller area proportion of raised zones, and not due to a TAD dryer. The permeability of the web results from the stretching of the web into the structure of the imprinting fabric by means of the suction element, whereby so-called pillows are produced which correspondingly increase the water absorbing capacity and the bulk. A relatively complex and correspondingly expensive TAD dryer is therefore no longer necessary for this.

The function of the TAD drum and of the through-air system consists of drying the web and, for this reason, the above mentioned alternate drying

apparatus (third pressure field) is preferable, since the third pressure field can be retrofitted to a conventional machine at lower cost than TAD.

To achieve the desired dryness, in accordance with an advantageous embodiment of the method in accordance with the invention, at least one felt with a foamed layer wrapping a suction roll is used for dewatering the web. In this connection, the foam coating can in particular be selected such that the mean pore size in a range from approximately 3 to approximately 6 µm results. The corresponding capillary action is therefore utilized for dewatering. The felt is provided with a special foam layer which gives the surface very small pores whose diameters can lie in the range set forth from approximately 3 to approximately 6 µm. The air permeability of this felt is very low. The natural capillary action is used for dewatering the web while this is in contact with the felt.

In accordance with an advantageous embodiment of the method in accordance with the invention, a so-called SPECTRA membrane is used for dewatering the web, said SPECTRA membrane preferably being laminated or otherwise attached to an air distribution layer, and with this SPECTRA membrane preferably being used together with a conventional, in particular woven, fabric.

Such a SPECTRA membrane can in particular be designed and manufactured as is described in GB 2 305 156 A in connection with its Figure 3 and in GB 2 235 705 B. The two publications just cited are hereby incorporated in the present application by reference.

The SPECTRA membrane can therefore in particular be a membrane with a regular, non-woven mesh structure through which suction is possible. It can be provide with spun reinforcement threads which extend through the

mesh structure in the web running direction (cf. in particular Figure 3 of GB 2 305 156 A). This SPECTRA membrane can in particular be a porous, reinforced membrane made from a composite, with spun threads or yarns extending in the machine direction forming the reinforcing elements and the surrounding matrix material including fluid passages, completely encapsulating the spun threads and connecting them to one another, spun thread for spun thread, to produce the non-woven SPECTRA membrane (cf. in particular GB 2 235 705 B). In other respects, the SPECTRA membrane can also in particular be designed and manufactured as is described in GB 2 305 156 A and GB 2 235 705 B.

As mentioned above, the SPECTRA membrane can, e.g., be laminated or otherwise attached to an air distribution layer.

Since the SPECTRA membrane has a relatively coarse cast structure, it is of advantage for it to preferably be used together with a conventional, in particular woven, fabric arranged between the SPECTRA membrane and for example a through flow cylinder. The distribution of the air flow is thus substantially improved, i.e. a more uniform distribution of the air/gas is achieved, and the drying is thus more uniform. This effect is advantageous when the surface of the through-flow cylinder has an open area of <25% and large land areas are provided between the holes.

Such a SPECTRA membrane can therefore in particular be used instead of the felt with a foamed layer. An anti-rewetting effect is utilized for dewatering instead of the capillary effect, in addition to.

In accordance with a further advantageous alternative embodiment of the method in accordance with the invention a so-called anti-rewetting mem-

brane or anti-rewetting fabric (or anti-rewet fabric) can also be used for dewatering the web.

The anti-rewetting membrane can in particular include the following:

- at least one air distribution fabric layer, with such an air distribution fabric layer being configured for coming into contact with the fiber web; and
- a perforated film layer, which can consist of a polyester film or of a plastic film, wherein the perforated film layer has a first film side and a second film side and wherein the first film side can be laminated or applied to the relevant air distribution fabric layer. The perforated film layer can also be brought into direct contact with the paper web, with in this case, however, the positive effect being substantially lower. A respective air distribution fabric layer can include a plain weave (linen bond) or a fabric of a plurality of floating threads (multi-float weave, multi-strand bond; weave type). The perforated film layer can include a series of perforation holes, which are spaced apart as closely as possibly, being separated from the others by a perforation space, with each air distribution fabric layer having an associated kind of material bond or weave and with the kind of material bond or weave having the ability to disperse the air over a distance greater than the perforation space. That means the weave repeat length should be equal to or larger than the perforation space. The bond kind or weave kind interval distance can in particular also be larger than the perforation space. The perforation film layer can have a series of perforation holes, with the perforation film layer being able to have, for example, approximately 40,000 holes per m^2. The perforation film layer can in particular have a series of per-

foration holes, with the perforation film layer being able to have, for example, less than approximately 200,000 holes per m^2. The perforation film layer can have an open area, for example, in the range from approximately 1% to approximately 30% and preferably in a range from, for example, approximately 5% to approximately 15%. The perforated film layer can, for example, have a thickness of less than approximately 0.04 inches, with the thickness, for example, being less than approximately 0.005 inches. Moreover, the anti-rewetting membrane can, for example, include a first air distribution fabric layer and a second air distribution fabric layer, with the first air distribution fabric layer being able to be laminated or applied to the first film side and with the second air distribution fabric layer being able to be laminated or applied to the second film side. A respective air distribution material layer could be, for example, a fabric with satin weave.

The anti-rewetting membrane can be used together with a conventional, in particular woven, fabric or also without an additional fabric or the like.

The method in accordance with the invention thus also provides the advantage that substantially higher dry contents of the tissue web are achieved even upstream of the dryer cylinder, in particular the Yankee cylinder, by avoiding the rewetting as a consequence of the embodiment of the method in accordance with the invention, while retaining the high specific bulk which is important for tissue. It is of particular advantage if the web is wet imprinted at a low dry content upstream of a dewatering unit or dewatering apparatus.

A pressure difference of the gas between the two sides of the paper web is absolutely necessary for the wet imprinting. The use of a suction box is particularly advantageous. The use of a pressure box with compressed air is also possible (pressure field one).

As already mentioned, the anti-rewetting membrane does not necessarily have to be used together with a conventional, in particular woven, fabric, since such an anti-rewetting membrane also has a good flow distribution effect.

A clothing, e.g. a fabric, felt with a foamed layer, a SPECTRA membrane – preferably together with a conventional, in particular woven, fabric – or an anti-rewetting membrane with or without a conventional, in particular woven, fabric, can be guided together with an imprinting fabric, e.g. a TAD fabric or an imprinting membrane, and a fiber web interposed therebetween around a suction roll, with the clothing preferably being in contact with the suction roll.

The clothing with a foamed layer, SPECTRA membrane, preferably together with a conventional, in particular woven, fabric or an anti-rewetting membrane with or without a conventional, in particular woven, fabric, can, for example, wrap a suction roll with a diameter from, for example, approximately 2 to 3 m, or a plurality of suction rolls with smaller diameters, preferably two suction rolls each with a diameter of, for example, approximately 2 m. The dwelling time of the web in the region of the suction roll or suction rolls should expediently be larger than approximately 0.15 s and less than approximately 0.40 s.

The relevant suction roll can have, for example, a vacuum applied to its lower side or a suction roll with an associated siphon extractor can be

used. In particular with a lower diameter, the water can, for example, also be spun into a channel by centrifugal force. The water can in particular also be blown off by means of an air knife.

Dewatering while utilizing the capillary effect is admittedly already described in US 5 701 682, but the relevant capillary element is here a part of the suction roll, which is disadvantageous for the conditioning of the capillary element.

The advantage of using a foamed fabric is to have better conditions for cleaning. The run of the fabric can be adapted for conditioning. The cleaning device can be arranged apart from the suction roll, i.e. apart from the process (no disturbance).

Despite the utilization of the capillary effect or of the anti-rewetting effect for the dewatering, the suction device can in particular have a pressurized hood to support the underpressure effect of the suction device and to be able to work at higher temperatures (e.g. ~140°C).

In accordance with a further preferred embodiment of the method in accordance with the invention, to drive out water by means of gas pressure, e.g. by an air press, the fiber web is guided together with an imprinting fabric at least once, possibly twice, through a pressure space which e.g. is bounded by at least four rolls arranged in parallel and lateral seal plates into which compressed gas is fed. In this connection, the fiber web is preferably guided together and in contact with the imprinting fabric between membranes through the pressure space, with preferably an air distribution membrane and an anti-rewetting membrane being used. The basic principle of such a displacement press in which the water in the fiber web is displaced by air, is described, for example, in DE 19946972.

As already mentioned above, the displacement press can alternatively comprise a U-shaped box.

A method in accordance with the invention for manufacturing a fiber web, in particular a web for tissue or hygiene material, which can be used alone or in combination with one or more of the above described methods, is characterized in that water is driven out of said fiber web by means of a displacement dewatering process, and a clothing arrangement is used which comprises, as regarded in the direction of the displacement fluid flow, the following elements: a membrane, an imprinting fabric, said fiber web, and an anti-rewet fabric; and in which said clothing arrangement is, in the direction of the displacement fluid flow, followed by an open surface of a counter means.

Suction means can be associated with said counter means. The counter means can, for example, comprise a vented roll, an open box, i.e. box with a sloted or drilled cover, or the like.

A fabric can be associated with the open surface of said counter means in order to provide a fluid distribution effect. The anti-rewet fabric can, for example, include at least one fluid or air distribution fabric layer, with said distribution fabric layer being configured for contacting the open surface of said counter means.

A method in accordance with the invention for dewatering a fiber web, in particular a web of tissue or hygiene material, is characterized in that to drive out water by means of gas pressure, e.g. by using an air press, the fiber web is guided together with an imprinting fabric at least once, and possibly twice, through a pressure space which is bounded e.g. by at least

four rolls arranged in parallel and into which a compressed gas is fed, and in that the fiber web is guided together with the imprinting fabric between membranes through the pressure space, with preferably an air distribution membrane and an anti-rewetting membrane being used. As mentioned above, also a U-shaped box can be used.

An apparatus in accordance with the invention for manufacturing a fiber web, in particular a web of tissue or hygiene material, provided with a three-dimensional surface structure is characterized in that the fiber web is pressed at a dry content of <35%, in particular <30%, and preferably <25% onto an imprinting fabric, e.g. by suction, by means of a first printing field and is thereby pre-imprinted, and in which the fiber web is guided through at least one pressure field (third pressure field) provided for dewatering and/or drying said fiber web. Preferably, the fiber web is once more pressed onto an imprinting fabric by means of a further pressure field (second pressure field) in order to fix strength without destroying the three-dimensional surface structure. The fiber web is preferably guided between the first pressure field (I) and the second pressure field (II) through said at least one third pressure field (III). Preferably, the same imprinting fabric is used in said first pressure field (I) and in said second pressure field (II).

Preferred embodiments of this apparatus in accordance with the invention are set forth in the dependent claims.

An apparatus in accordance with the invention for manufacturing a fiber web, in particular a web or tissue of hygiene material, is characterized in that it comprises a displacement dewatering device for driving water out of said fiber web and a clothing arrangement including, as regarded in the direction of the displacement fluid flow, the following elements: a mem-

brane, an imprinting fabric, said fiber web, and an anti-rewet fabric. Preferably, said clothing arrangement is followed, in the direction of the displacement fluid flow, by an e.g. vented roll with an open surface.

Preferred embodiments of this apparatus in accordance with the invention are set forth in the dependent claims.

An apparatus in accordance with the invention for dewatering a fiber web, in particular a web of tissue or hygiene material, is characterized in that, to drive out water by means of gas pressure, the fiber web is guided together with an imprinting fabric at least once, and possibly twice, through a pressure space which is bounded by e.g. at least four rolls arranged in parallel and into which a compressed gas can be led, and in that the fiber web is guided together with the imprinting fabric and between membranes through the pressure space, with preferably an air distribution membrane and an anti-rewetting membrane being used.

One aspect of the invention as defined in the claims is the fabric order. According to a preferred embodiment, a corresponding clothing arrangement can include, as regarded in the direction of the displacement fluid flow, the following elements: a membrane, an imprinting or embossing fabric, the fiber web or sheet, and an anti-rewet fabric. Consequently, the following fabric order could, for example, be used: membrane/molding/sheet/anti-rewet layer. Such a fabric order can in general be applied to vacuum assisted displacement dewatering (i.e. use of membrane/molding/sheet/anti-rewet fabric/vacuum box or the like). The mentioned fabric order can, for example, be applied to displacement presses of different types. For example, a corresponding displacement press can comprise a U-shaped box, a cluster of four or more rolls. Specifically a tandem (two or more displacement presses) or the like can be

provided. An embossing or imprinting fabric is not in any case necessary. A non-molding transfer fabric could be used or the membrane or the anti rewet layer could be a transfer fabric. Such an embodiment without an imprinting fabric is not specific to tissue alone. Another aspect of the invention is the use of a membrane used to mold or not mold (for graphic paper) sheet, with an anti-rewet fabric under the sheet.

The membrane according to the present invention reduces air flow, makes it possible to build pressure, reduce process air cost, presses in embossing or imprinting fabric, prevents blowing off the paper web from the imprinting fabric (reduced air flow) and makes it possible to generate further mechanical pressure which causes high strength areas in sheet.

The embossing or imprinting fabric carries the sheet or fiber web through the process. The imprinting fabric needs a pattern, surface energy, open area and/or surface texture that holds sheet without letting the sheet transfer to anti-rewet layer. It further concentrates membrane pressure into specific areas. The structure of imprinting fabric causes pressure pattern that rates high strength areas in sheet. The unpressed areas give bulk to the sheet despite pressing. Most of sheet is not pressed. The imprinting fabric can balance sheet strength with sheet adsorbancy depending on imprinting fabric structure. The imprinting fabric releases its water into sheet thus it has no water to rewet the sheet. The imprinting fabric can carry sheet through drying process. If this is done, drying will take less energy than current TAD technology since imprinting fabric and sheet are at a much dryer level. For lowest air consumption, imprinting fabric mainly allows vertical flow of air.

The anti-rewet fabric prevents rewet of sheet. The air flow from displacement process isolates water. The anti-rewet fabric does not pick up sheet

from imprinting fabric. It protects sheet from process water after the displacement or gas press.

The present invention provides a new process that has many of the advantages of the known processes, without some of the disadvantages. This invention creates a sheet with high bulk, but does it using less energy and small, simpler equipment. More importantly, it can be added as a rebuild to an extending "Yankee" tissue machine making flat sheet. Furthermore, it can reduce energy consumption.

The invention can be used in particular with crescent formers, duo formers, C wrap formers, S wrap formers and in the manufacture of single layer and/or multi-layer and multi-ply tissue.

The invention will be described in more detail in the following with reference to embodiments and to the drawing, in which are shown:

Figure 1 a schematic part representation of an embodiment of an apparatus for manufacturing a fiber web provided with a three-dimensional surface structure in which a dewatering apparatus (third pressure field) is additionally provided in which the capillary action of a felt with a foamed layer, the action of a SPECTRA membrane, preferably with an associated conventional, in particular woven, fabric, or the action of an anti-rewetting membrane with or without a conventional, in particular woven, fabric is utilized for dewatering;

Figure 1a a schematic representation of the dewatering apparatus with a SPECTRA membrane or an anti-rewetting membrane, optionally with an additional conventional fabric;

Figure 2 a schematic part representation of a further embodiment of an apparatus for manufacturing a fiber web provided with a three-dimensional surface structure in which a dewatering apparatus is additionally provided in which the capillary action of a felt with a foamed layer, the action of a SPECTRA membrane, preferably with an associated conventional, in particular woven, fabric, or the action of a anti-rewetting membrane with or without a conventional, in particular woven, fabric is utilized for dewatering;

Figure 2a a variant with a pick-up or separation element for a better web transfer;

Figure 3 a schematic part representation of an embodiment of an apparatus for manufacturing a fiber web provided with a three-dimensional surface structure in which a displacement press is additionally provided;

Figure 4 a schematic part representation of a further embodiment with a displacement press;

Figure 5 a schematic part representation of a further embodiment with a displacement press;

Figure 6 a schematic part representation of an imprinting fabric with a smaller area proportion of raised zones in comparison with the area proportion of recessed zones;

Figure 7 a schematic section through a press nip through which the imprinting fabric shown in Fig. 5 is led together with the fiber web, and

Figures 8 to 15 graphs illustrating advantages of some of the aspects of the present invention.

In the embodiment as described in the following at least one imprinting fabric is used which could be a woven TAD (through-air-drying) or casted SPECTRA fabric in a continuous loop.

Figure 1 shows in a schematic part representation an embodiment of an apparatus 10 for manufacturing a fiber web 12 provided with a three-dimensional surface structure in which a dewatering apparatus 34 (third pressure field) is provided in which, for example, the capillary action of a felt 36 with a foamed layer is utilized for dewatering. In this connection, the foam coating can in particular be selected such that the mean pore size results in a range from approximately 3 to approximately 6 µm.

Figure 1 shows, as an example for conditioning means or a cleaning device 80, water shower nozzles or air nozzles. One of the advantages of a foamed fabric is that it is easily accessible for cleaning purposes. That is, the fabric can be cleaned from the outside, from the inside or form both sides. As cleaning devices also suction means, e.g. pipe suction means, alone or in combination with water shower nozzles and/or air nozzles, could be used.

Instead of a felt with a foamed layer, a so-called SPECTRA membrane can, for example, also be used, with this SPECTRA membrane preferably being

used together with a conventional, in particular woven, fabric. Alternatively, a so-called anti-rewetting membrane can also be used. Such an anti-rewetting membrane can be used together with a conventional, in particular woven, fabric or also without such an additional fabric or the like.

In the present case, the felt 36 with a foamed layer is guided together with an imprinting fabric 14 and a fiber web 12 interposed therebetween about a larger suction roll 38, with the felt 36 preferably being in contact with the suction roll 38. The suction roll 38 wrapped, for example, by the felt 36 with a foamed layer can, for example, have a diameter from approximately 2 to approximately 3 m. The suction roll 38 can have a vacuum applied to its lower side. Generally, a siphon extractor can also be associated with the suction roll 38. Or a tray 40 can be used to take off the water and/or air, which can be blow out of the mantle of the roll.

In the forming region, at least one dewatering fabric with zonally different fabric permeability can be provided.

In the present case, a former with two peripheral dewatering fabrics 14, 42 is provided, with the inner fabric 14 simultaneously serving as the imprinting fabric. The two dewatering fabrics 14, 42 run together while forming a pulp run in gap and are guided over a forming element 46 such as in particular a forming roll.

In the present case, the imprinting fabric 14 is used as the inner fabric of the former which comes into contact with the forming element 46. The outer fabric 42, which does not come into contact with the forming element 46, can in particular be provided as a dewatering fabric with zonally different fabric permeability.

The fiber suspension is introduced into the pulp run in gap 44 by means of a head box 48. A pick-up element or separation element 50 which can be configured such that it acts as part of the pressure field I, is provided downstream of the forming element 46 and the web is held on the imprinting fabric 14 by this during the separation from the dewatering fabric 42. A suction element 16 (solid representation) as the other part of pressure field I is preferably provided upstream of the apparatus 34 with capillary action or, for example, of the action of a SPECTRA membrane or of an anti-rewetting membrane with or without an additional conventional fabric and the fiber web 12 is sucked into the 3-dimensional structure of the imprinting fabric 14 by this. This suction element can, however, also be arranged between the apparatus 34 with, for example, capillary action, etc. and the suction device or suction roll 30 (broken line representation 16') to prevent the paper web of separating from the imprinting fabric.

The fiber web 12 and the imprinting fabric 14 are guided through the press nip 18 (pressure field II) formed between a dryer cylinder 20 and a shoe press unit 22. The shoe press unit 22 includes a flexible sleeve 26 guided over a press shoe 24 in the region of the press nip 18. The imprinting fabric 14 and the fiber web 12 are guided upstream of the press nip about a suction device 30 which can in particular be a suction roll. The dryer cylinder 20 can in particular be a Yankee cylinder. In this connection, a dryer hood 52 can be associated with this dryer cylinder 20.

In the present example, the dry content of the fiber web upstream of the dewatering apparatus 34 amounts to approximately 10 to approximately 25%; in the region downstream of this apparatus 34, for example approximately 30 to approximately 40%.

The fiber web 12 is therefore in particular pressed, e.g. sucked, at a dry content of <30%, in particular <25%, in particular <15% and preferably <10%, onto the imprinting fabric or structured fabric 14 by means of a first pressure field I in the region of the suction element 16 and/or in the region of the separation element 50 and is thereby pre-imprinted, in particular, and is subsequently once more pressed onto the imprinting fabric 14 by means of a further pressure field II in the region of the press nip 18 in order to fix and/or increase strength without destroying the 3-dimensional structure of the sheet and for the transfer to the drying cylinder.

Figure 1a shows in a schematic representation the dewatering apparatus 34 with a SPECTRA membrane 36 which is used in the present example together with a conventional, in particular woven, fabric 76. In this Figure 1a, a vacuum producing apparatus such as in particular the suction cylinder or the large suction roll 38 and the imprinting fabric or imprinting fabric 14 can also again be recognized.

The embodiment shown in Figure 2 initially differs from that in accordance with Figure 1 in that the fiber web 12 is taken over by the imprinting fabric 14 from an inner fabric 54 of the former. In the present case, for example, this inner fabric 54 or preferably the outer fabric 42 of the former can again be provided as a dewatering fabric with zonally different fabric permeability. The two peripheral dewatering fabrics 42, 54 again run together while forming a pulp run in gap 44, with them again being guided via a forming element 46 such as in particular a solid or suction forming roll. The pulp run in gap 44 is again charged with fiber suspension by means of a head box 48. In contrast to the embodiment in accordance with Figure 1, the fiber suspension is, however, supplied from below in the present case.

A pick-up element or separation element 50 is again provided within the loop of the imprinting fabric 14 and the fiber web 12 is held on the imprinting fabric by this on the separation from the inner fabric 54 of the former.

The suction element 16 provided within the loop of the imprinting fabric 14 is arranged upstream of the dewatering apparatus 34 with a capillary action or, for example, of the action of a SPECTRA membrane or of an anti-rewetting membrane with or without an additional, conventional fabric, with generally, however, an arrangement downstream of this apparatus 34 also being possible.

The dry content of the fiber web in the present example amounts to approximately 10 to approximately 25% in the region of the pick-up element 50, approximately 15 to approximately 30% in the region upstream of the dewatering apparatus 34 and approximately 35 to approximately 45% in the region downstream of this apparatus 34. In this case, e.g. a pressing roll 30 (suction roll) can be provided instead of a shoe press unit. The pressing roll can also be a solid roll.

The turning roll 29 provided adjacent to the dewatering apparatus 34 can also be a suction roll for a better web transfer.

Another variant with a pick-up element or a separation element for a better web transfer is shown in Figure 2a.

In another respect, this embodiment can have at least substantially the same design as that in accordance with Figure 1. Elements corresponding to one another are assigned the same reference numerals.

Figure 3 shows in a schematic part representation an embodiment of the apparatus 10 in which a displacement press 56 (pressure field III) is provided. In this connection, to drive out water by means of gas pressure, the fiber web 12 is guided together with the imprinting fabric 14 at least once through a pressure space 58 which is bounded by at least four rolls 60 – 66 arranged in parallel and into which compressed gas can be led. Consequently, the embodiment of Figure 3 differs from that of Figures 1 and 2 in that such a roll arrangement 60 – 66 defining the pressure space 58 is used. In this connection, the fiber web 12 is preferably guided through the pressure space 58 together with the imprinting fabric 14 and a membrane 72 for air distribution as well as an anti-rewetting membrane 36. The fiber web is sandwiched between the imprinting fabric 14 and the anti-rewetting membrane.

The imprinting fabric 14 could be a SPECTRA membrane in which case all the air is forced vertically through the sheet because it is a cast structure without cross over points. Cross flows in between the membrane and therefore air leakage in machine direction is eliminated.

In the present case, the imprinting fabric 14 forms the inner fabric of the former which in turn includes a forming element 46 such as in particular a forming roll in whose region the inner fabric provided as the imprinting fabric 14 and the outer fabric 42 run together while forming a pulp run in gap 44 which is charged with fiber suspension by means of a head box 48.

Subsequently to the air press 56, the fiber web 12 is again guided with the imprinting fabric 14 over a suction device 30, in particular a suction roll, and through the press nip 18 (pressure field II) formed between a dryer cylinder 20, in particular a Yankee cylinder, and a shoe press unit 22. In

the example shown, a dryer hood 52 is again associated with the dryer cylinder or Yankee cylinder 20.

In the present case, the first pressure field I, through which the fiber web 12 is pressed onto the imprinting belt 14 and correspondingly pre-imprinted at a dry content of in particular <30%, in particular <25%, in particular <15%, and preferably <10%, can be produced by the suction element 16.

Figure 4 shows in a schematic part representation a further embodiment with a displacement or air press 56.

The embodiment initially differs from that in accordance with Figure 3 in that the inner fabric 78 of the former is provided separately from the imprinting fabric 14 and the fiber web 12 is transferred to the imprinting fabric 14 from the inner fabric 78. Moreover, the fiber suspension is poured into the pulp run in gap 44 diagonally from the bottom to the top by means of the head box 48.

Furthermore, in the present example, the suction device 30 provided in the embodiment in accordance with Figure 3 is omitted. Instead of the shoe press unit 22, a conventional press roll 28, solid or suction roll, is provided, for example, which forms the press nip 18 with the dryer cylinder 20, in particular the Yankee cylinder.

The membrane 72 can, for example, be a fine membrane fir air distribution and the membrane 36 can for example, be a laminated coarse cast structure SPECTRA membrane and/or an anti-rewetting membrane.

In another respect, this embodiment shown in Figure 4 can again have at least substantially the same design as that in Figure 3.

Figure 5 shows in a schematic part representation a further embodiment of the apparatus with a displacement press 56.

In this case, the displacement press 56 comprises a U-shaped box 82. The air pressure within the U-shaped box 82 provides an air flow 84 through the membrane 72, preferably an air distribution membrane, the imprinting fabric 14, the fiber web 12 and the membrane 36, as regarded in the direction of the air flow 84. The membrane 36 can, for example, be a SPECTRA membrane or an anti-rewetting membrane.

As can be recognized, for example, with reference to Figures 6 and 7, the respective imprinting fabric 14, e.g. a woven fabric with raised Knuckles (cf. in particular the left hand part of Fig. 6) or imprinting membrane (cf. in particular the right hand part of Fig. 6), guided through the press nip 18 can be structured such that for this imprinting fabric 14 a smaller area proportion of raised or closed zones 68 results in comparison with the area proportion of recessed zones or holes 74 and accordingly a smaller area proportion of the fiber web 12 is pressed in the press nip 18.

In this connection, the contact area proportion of raised or closed zones 68 can in particular be $\leq$40% and can preferably lie in a range from approximately 20 to approximately 30% and in particular at approximately 25%. The contact area need not to be the same as the open area or the void volume. The open area or the void volume of a fabric can be independent of the contact area.

The raised zones 68 and the recessed zones can result, for example, due to offsets, i.e. due to intersection points of picks and ends, of a woven fabric. In the case of the pressing membrane reproduced in the right hand part of Figure 6, a corresponding structure arises due to the holes 74.

Figure 6 shows a schematic part representation of a corresponding imprinting fabric 14, e.g. imprinting fabric or imprinting membrane, with a smaller area proportion of raised or closed zones 68 in comparison with an area proportion of recessed zones or holes 74.

The thickness d of the imprinting membrane shown in the right hand part of Figure 6 can amount, for example, approximately to 1 to approximately 3 mm. The membrane expediently consists of a material resistant to the fiber chemistry. It can consist, for example, of polyurethane.

Figure 7 shows a schematic section through a press nip 18 through which the imprinting fabric 14 shown in Figure 5 is guided together with the fiber web 12. In this connection, this imprinting fabric 14 is in contact with the flexible sleeve 26 of the shoe press unit which is guided in the region of the press nip 18 over a press shoe 24 via which the desired pressing force can be applied.

The fiber web 12 contacts the dryer cylinder 20, preferably a Yankee cylinder.

Moreover, in Figure 7, the pressing zones 70 resulting as a consequence of the raised zones 68 can be recognized.

The fiber web 12 is already imprinted upstream of the nip. As can be recognized with reference to Figure 7, it already contacts the imprinting fabric upstream of the nip.
Some of the above mentioned aspects of the present invention are exemplified in more detail in the following:

Recently, the applicant has been developing a new mechanical process for dewatering paper using high pressure air. Prior to these developments, no continuous method was available for pressing a sheet of paper using the pressures which can now be developed.

One of the presses which can, e.g., be used as an air press is called a BCP (Beck Cluster Press). Its preferred state is shown in Figure 8.

The center of the 4 roll cluster along with roll ends seals form "a chamber" that can be pressurized. The web passes through the nips into the pressure chamber. While in the chamber, the web feels a pressure gradient between the chamber and the vented main roll.

Because of this gradient, air flows from the chamber, through the web and into the vented main roll. The motion of the air through the web, and the pressure of the chamber, dewaters the sheet. The extent of sheet dewatering depends on the web make up and pressing conditions such as pressure, speed, and temperature.

Published research has shown that good sheet dewatering occurs when the sheet is mechanically pressed and at the same time, air is passed through the sheet. This process is called "displacement dewatering". A "membrane" fabric can be used as the upper most layer in the web. The membrane reduces airflow to the level needed for dewatering, and at the

same time, acts like a piston, to convert air pressure into mechanical pressure. Thus, the membrane acts to press and to control airflow through the rest of the web and sheet.

After the membrane layer, the following layers can be varied to influence pressing conditions. For example, consider the web passing through the BCP displacement press as constructed in the layers shown below:

High Pressure air
Membrane
Sheet
Imprinting fabric
Support fabric
Vented roll

For projected commercial displacement pressing conditions, using this configuration the sheet will have solids exiting the BCP in the range of 20 % for a 20 – 30 GSM tissue sheet. With this solids content, there is no advantage of the displacement pressing method over conventional pressing methods. The sheet is simply too wet.

If, however, the basis weight of the sheet is increased with this web configuration, as shown in Figure 9, the sheet solids increase. This means the displacement pressing process is capable of high solids, but at low sheet basis weight the sheet solids will be very low, due to the sheet re-adsorbing water after pressing (cf. Figure 9).

According to one embodiment of the present invention the imprinting fabric is put on the high pressure side, next to the membrane. The web configuration was changed to:

High Pressure Air
Membrane
Imprinting fabric
Sheet
Support fabric
Vented roll (low pressure)

This configuration indeed, did increase sheet solids for the tissue sheets. Sheet solids increased from under 20% to about 32 % for the 22 GSM tissue sheet. Again interestingly, increasing sheet basis weight causes increases in solids content (cf. Figure 10).

Figure 11 shows a "Sweet" plot for the two web configurations. The Sweet plot is a way of estimating the amount of rewet in such cases. To make a Sweet plot, one plots 1/(Sheet Basis Weight) on the x axis against sheet dryness on the y axis. The Y intercept from such a plot indicates the theoretical maximum solids attainable if no rewet existed.

This Sweet plot shows that both web conditions would yield solids of about 51 % if there were no rewet present. Thus, by moving the embossing fabric on top of the sheet, we had greatly increased sheet solids for low basis weight tissue, but the Sweet plot shows that our 32 % tissue solids is a long way from the maximum solids of 51 % attainable for our conditions.

Additional research led the applicant develop an anti-rewet fabric that virtually eliminates sheet rewet. This fabric, placed underneath the sheet (cf. Figure 12), vastly inhibits water from passing back into the sheet after displacement pressing.

By putting the anti-rewet fabric under the tissue sheet, a gain in sheet dryness was seen. We get the improvement in solids as shown in figure 13.

By using the imprinting fabric on the top of the sheet, and the anti-rewet fabric on the bottom of the sheet, rewet has been greatly decreased, so that a 25 GSM tissue sheet now has solids close to the values predicted by Sweet.

From the above discussion, it can be seen that one aspect of the present invention is the order and type of fabrics used in the displacement pressing process. One object of the present invention is to reach the highest sheet solids possible, at the lowest cost and without greatly affecting the bulk of the sheet. The fabric positions and types are one part of attaining this goal. By putting the imprinting fabric on the top of the sheet, and the anti-rewet layer underneath, high solids can be reached through mechanical removal of water. To create the mechanical pressure and limit the air flow a membrane with a low permeability is used. The permeability is e.g. less than 15 cfm, preferably less than 10 cfm, preferably less than 8 cfm, measured by TAPPI test method TIP 0404-20. In addition it is advantageous to operate the air press for displacement dewatering with a pressure in the chamber of > 30 psi, preferably > 40 psi.

Mechanical removal of water is much cheaper than evaporative drying, so an object of the present invention is to reach the highest solids possible without evaporative drying. For our process, we have found that the amount of air that is passed through the sheet is best measured as a film thickness of atmospheric air. As the film thickness of air pushed through the sheet increases, the water removal process progresses. The more air

pushed through the sheet, the dryer the sheet becomes. This behavior for the displacement pressing process is shown in Figure 14.

From this plot, we can see that initially, a thin air film will remove a lot of water. But as the dryness of the sheet increases, it takes more and more air to remove water from the sheet.

There are two fundamentally different dewatering mechanisms taking place. The first mechanism is the displacement pressing phase. During this phase, water primarily leaves the sheet as a liquid. The water moves out of the sheet and into the anti-rewet layer and/or the vented roll. In general, it takes less than 5" and generally 5" or less of air film (thickness) to remove water in the displacement pressing phase.

To increase sheet dryness in the displacement pressing phase, air pressure should be increased. Increasing air pressure increases mechanical pressure, which increases the ultimate dryness attainable by the process. There are limits to this as is seen in Figure 15.

From this graph it is obvious that vacuum dewatering (which is a low-pressure process) as is being done currently by most TAD processes, will only give low dryness sheets. If the objective is to remove the most water in the displacement pressing phase, it's important to use pressure that is high enough for the paper being dewatered.

Reference numeral list

10	apparatus
12	fiber web
14	imprinting fabric
16	suction element
18	press nip
20	dryer cylinder, Yankee cylinder
20'	surface
22	opposing element, shoe press unit
24	press shoe
26	flexible sleeve, flexible roll sleeve
29	turning roll
30	suction device, suction roll
34	dewatering apparatus with capillary action or anti-rewetting action
36	felt with foamed layer, SPECTRA membrane or anti-rewetting membrane
38	large suction roll
40	vacuum, box
42	dewatering fabric
44	pulp run in gap
46	forming element, forming roll
48	head box
50	pick-up element or separation element
52	dryer hood
54	inner dewatering fabric
56	air press
58	pressure space
60	roll

62	roll
64	roll
66	roll
68	raised zones
70	pressing zones
72	air distribution membrane
74	holes
76	conventional fabric
78	inner fabric
80	cleaning device
82	U-shaped box
84	air flow
d	thickness
L	web running direction
I	first pressure field
II	further pressure field

Claims

1. A method for manufacturing a fiber web, in particular a web of tissue or hygiene material, provided with a three-dimensional surface structure in which the fiber web is pressed at a dry content of <35%, in particular <30%, and preferably <25% onto an imprinting fabric by means of a first pressure field and is thereby pre-imprinted and in which the fiber web is guided through at least one pressure field (third pressure field) provided for dewatering and/or drying said fiber web.

2. The method in accordance with claim 1, characterized in that the fiber web is once more pressed onto an imprinting fabric by means of a second pressure field in order to fix strength without destroying the three-dimensional surface structure.

3. The method in accordance with claim 2, characterized in that the fiber web is guided between the first and the second pressure field through said at least one third pressure field.

4. The method in accordance with claim 2 or 3, characterized in that the same imprinting fabric is used in said first pressure field and in said second pressure field.

5. The method in accordance with any one of the preceding claims, characterized in that a woven or a casted fabric in a continuous loop is used as the imprinting fabric.

6. The method in accordance with any one of the preceding claims, characterized in that a TAD (through-air-drying) fabric or an imprinting membrane is used as the imprinting fabric.

7. The method in accordance with any one of the preceding claims, characterized in that the fiber web is pre-imprinted downstream of the forming region.

8. The method in accordance with any one of the preceding claims, characterized in that the fiber web is formed on the imprinting fabric used for imprinting.

9. The method in accordance with any one of the preceding claims, characterized in that the fiber web is transferred onto the imprinting fabric used for pre-imprinting.

10. The method in accordance with any one of the preceding claims, characterized in that the same imprinting fabric is used for pre-imprinting and for fixing strength.

11. The method in accordance with any one of the preceding claims, characterized in that at least the first pressure field is produced by means of at least one suction or pressure element arranged at the side of the imprinting fabric remote from the fiber web to suck or press the fiber web into the surface structure of the imprinting fabric.

12. The method in accordance with claim 11, characterized in that a wet suction box or pressure box is used as the suction or pressure element.

13. The method in accordance with any one of the preceding claims, characterized in that the fiber web is pressed gently in the second pressure field, i.e. preferably over an extended nip in the web running direction.

14. The method in accordance with any one of the preceding claims, characterized in that the second pressure field is produced by means of a press nip.

15. The method in accordance with claim 14, characterized in that the press nip forming the second pressure field is produced between a dryer cylinder and an opposing element, with the fiber web guided through the press nip being in contact with the surface of the dryer cylinder and contacting the imprinting fabric with its other side.

16. The method in accordance with claim 15, characterized in that a Yankee cylinder is used as the dryer cylinder.

17. The method in accordance with claim 15 or claim 16, characterized in that a shoe press unit is used as the opposing element interacting with the dryer cylinder and includes a flexible sleeve guided via a press shoe in the region of the press nip.

18. The method in accordance with claim 17, characterized in that a shoe pressing roll provided with a flexible roll sleeve is used as the shoe press unit.

19. The method in accordance with claim 15 or claim 16, characterized in that a pressing roll or a suction pressing roll is used as the opposing element interacting with the dryer cylinder.

20. The method in accordance with any one of the preceding claims, characterized in that the pre-imprinted fiber web is dried on the dryer cylinder; in that the fiber web is creped and/or in that the fiber web is subsequently wound up.

21. The method in accordance with any one of the preceding claims, characterized in that the dry content at which the fiber web is pre-imprinted and/or the dry content at which the three-dimensional surface structure is created is respectively selected at <30%, in particular <25%, in particular <15%, and preferably <10%.

22. The method according to any one of the preceding claims, characterized in that said third pressure field is provided between said first pressure field and said second pressure field.

23. The method in accordance with any one of the preceding claims, characterized in that a drying apparatus is used in order to provide said third pressure field.

24. The method in accordance with claim 23, characterized in that a suction or pressure device is used as a drying apparatus.

25. The method in accordance with any one of the preceding claims, characterized in that the fiber web is guided together with an imprinting fabric both through the third pressure field and the second pressure field.

26. The method in accordance with claim 24 or 25, characterized in that the suction or pressure device has a curved surface and the fiber web and the imprinting fabric are guided over this curved area.

27. The method in accordance with claim 26, characterized in that a suction roll is used as the suction device.

28. The method in accordance with any one of the preceding claims, characterized in that the suction device has a pressurized hood to support the vacuum effect of the suction device.

29. The method in accordance with any one of the preceding claims, characterized in that said third pressure field is provided by a gas press, preferably, an air press.

30. The method in accordance with claim 29, characterized in that said gas press comprises an arrangement of at least four rolls.

31. The method in accordance with claim 29, characterized in that said gas press comprises a U-shaped box.

32. The method in accordance with any one of the preceding claims, characterized in said gas press is operated with a pressure in its chamber of > 30 psi, preferably > 40 psi.

33. The method in accordance with any one of the preceding claims, characterized in that the length of the press nip of the shoe press including the dryer cylinder and the shoe press unit observed in the web running direction is selected to be larger than a value of ap-

proximately 80 mm and the shoe press is designed such that a pressure profile results over the press nip length with a maximum pressing pressure which is smaller than or equal to a value of approximately 2.5 MPa.

34. The method in accordance with any one of the preceding claims, characterized in that at least one dewatering fabric with a zonally different fabric permeability is used in the forming region.

35. The method in accordance with claim 30, characterized in that a former, e.g. a twin wire former, is used with two circulating dewatering fabrics which run together while forming a pulp run-in gap and are guided over a forming element such as in particular a forming roll; and in that a dewatering fabric with a zonally different fabric permeability is used as an outer fabric not coming into contact with the forming element and/or as an inner fabric.

36. The method in accordance with claim 35, characterized in that an imprinting fabric is used as the inner fabric and a dewatering fabric with zonally different fabric permeability is preferably used as the outer fabric.

37. The method in accordance with claim 36, characterized in that the fiber web is preferably transferred from the inner fabric to an imprinting fabric.

38. The method in accordance with any one of the preceding claims, characterized in that an imprinting fabric, e.g. a TAD fabric or an imprinting membrane, is guided through the press nip and is structured such that for this imprinting fabric a smaller contact area

portion formed by raised or closed zones results in comparison with the non-contact area portion formed by recessed zones or holes and correspondingly a smaller contact area portion of the fiber web is pressed in the press nip.

39. The method in accordance with claim 38, characterized in that an imprinting fabric is used in which the contact area proportion of raised or closed zones is ≤40% and preferably lies in a range from approximately 20% to approximately 30%, and in particular at approximately 25%.

40. The method in accordance with claim 38 or claim 39, characterized in that an imprinting fabric is used in which the raised zones and the recessed zones result from offsets, i.e. from intersection points of picks and ends, of the fabric.

41. The method in accordance with any one of the preceding claims, characterized in that at least one felt with a foamed layer is used for dewatering the web.

42. A method in accordance with claim 41, characterized in that the foam coating is selected such that the mean pore size results in a range from approximately 3 to approximately 6 μm.

43. The method in accordance with any one of claims 1 to 40, characterized in that a so-called SPECTRA membrane is used for dewatering the web, said SPECTRA membrane preferably being laminated or otherwise attached to an air distribution layer, and with this SPECTRA membrane preferably being used together with a conven-

tional, in particular a woven, fabric, arranged between the SPECTRA membrane and for example a through flow cylinder.

44. The method in accordance with any one of claims 1 to 40, characterized in that a so-called anti-rewetting membrane is used for dewatering the web.

45. The method in accordance with claim 44, characterized in that the anti-rewetting membrane is used together with a conventional, in particular a woven, fabric.

46. The method in accordance with claim 44, characterized in that the anti-rewetting membrane is used without an additional fabric or the like.

47. The method in accordance with any one of the preceding claims, characterized in that a clothing, e.g. a fabric, felt with a foamed layer, a SPECTRA membrane preferably together with a conventional, in particular woven, fabric or an anti-rewetting membrane with or without a conventional, in particular woven, fabric, is guided together with an imprinting fabric and a fiber web interposed therebetween about at least one suction roll, with the clothing preferably being in contact with the suction roll.

48. The method in accordance with any one of claims 41 to 47, characterized in that the clothing with a foamed layer, SPECTRA membrane preferably together with a conventional, in particular woven, fabric or an anti-rewetting membrane with or without a conventional, in particular woven, fabric, wraps a suction roll with a diameter from approximately 2 to approximately 3 m or a plurality of

suction rolls with smaller diameters, preferably two suction rolls with a diameter from, for example, approximately 2 m in each case.

49. The method in accordance with any one of claims 41 to 48, characterized in that the suction roll has a vacuum applied to its lower side.

50. The method in accordance with any one of the preceding claims, characterized in that a vacuum is applied to the journal of the suction roll.

51. The method in accordance with any one of claims 41 to 48, characterized in that a suction roll with an associated siphon extractor is used or the water is spun into a channel by centrifugal force.

52. The method in accordance with any one of the preceding claims, characterized in that the water is blown off by means of an air knife.

53. The method in accordance with any one of the preceding claims, characterized in that, to drive out water by means of gas pressure, e.g. air pressure, the fiber web is guided together with an imprinting fabric at least once, and possibly twice, through a pressure space which is bounded by at least four rolls arranged in parallel and into which a compressed gas is led.

54. The method in accordance with any one of the preceding claims, characterized in that the fiber web is guided together with the imprinting fabric between membranes through the pressure space, with preferably an air distribution membrane and an anti-rewetting membrane being used.

55. The method in accordance with any one of the preceding claims, characterized in that the thickness of the imprinting membrane amounts to approximately 1 to approximately 3 mm.

56. A method for manufacturing a fiber web, in particular a web of tissue or hygiene material, in particular in accordance with any one of the preceding claims, in which water is driven out of said fiber web by means of a displacement dewatering process, and a clothing arrangement is used which comprises, as regarded in the direction of the displacement fluid flow, the following elements: a membrane, an imprinting fabric, said fiber web, and an anti-rewet fabric; and in which said clothing arrangement is, in the direction of the displacement fluid flow, followed by an e.g. vented roll with an open surface.

57. The method in accordance with claim 56, characterized in that suction means are associated with said counter means.

58. The method in accordance with claim 56 or 57, characterized in that said counter means comprises a vented roll.

59. The method in accordance with claim 56 or 57, characterized in that said counter means comprises an open box.

60. The method in accordance with any one of the claims 56 to 59, characterized in that a fabric is associated with the open surface of said counter means in order to provide a fluid distribution effect.

61. The method in accordance with any one of the claims 56 to 59, characterized in that said anti-rewet fabric includes at least one fluid or air distribution fabric layer, said distribution fabric layer being configured for contacting the open surface of said counter means.

62. A method for dewatering a fiber web, in particular a web of tissue or hygiene material, characterized in that, to drive out water by means of gas pressure, e.g. by using a gas press, preferably an air press, the fiber web is guided together with an imprinting fabric at least once, and possibly twice, through a pressure space which is bounded e.g. by at least four rolls arranged in parallel and into which a compressed gas is led and in that the fiber web is guided together with the imprinting fabric between membranes through the pressure space, with preferably an air distribution membrane and an anti-rewetting membrane being used.

63. The method in accordance with any one of the preceding claims, characterized in that instead of a molding membrane a non-molding membrane is used for manufacturing graphic paper.

64. An apparatus (10) for manufacturing a fiber web (12), in particular a web of tissue or hygiene material, provided with a three-dimensional surface structure in which the fiber web (12) is pressed at a dry content of <35%, in particular <30%, and preferably <25% onto an imprinting fabric (14) by means of a first pressure field (I) and is thereby pre-imprinted, and in which the fiber web is guided through at least one pressure field (third pressure field III) provided for dewatering and/or drying said fiber web (12).

65. The apparatus in accordance with claim 64, characterized in that the fiber web is once more pressed onto an imprinting fabric (14) by means of a second pressure field (II) in order to fix strength without destroying the three-dimensional surface structure.

66. The apparatus in accordance with claim 65, characterized in that the fiber web is guided between the first pressure field (I) and the second pressure field (II) through said at least one third pressure field (III).

67. The apparatus in accordance with claim 65 or 66, characterized in that the same imprinting fabric is used in said first pressure field (I) and in said second pressure field (II).

68. The apparatus in accordance with any one of the preceding claims, characterized in that a woven or a casted fabric in a continuous loop is provided as the imprinting fabric (14).

69. The apparatus in accordance with any one of the preceding claims, characterized in that a TAD (through-air-drying) fabric or an imprinting membrane TAD (through-air-drying) fabric is provided as the imprinting fabric (14).

70. The apparatus in accordance with claim 68 or claim 69, characterized in that the fiber web (12) is imprinted downstream of the forming region.

71. The apparatus in accordance with any one of the preceding claims, characterized in that the fiber web (12) is formed on the imprinting fabric (14) used for imprinting.

72. The apparatus in accordance with any one of the preceding claims, characterized in that the fiber web (12) is transferred onto the imprinting fabric (14) used for pre-imprinting.

73. The apparatus in accordance with any one of the preceding claims, characterized in that the same imprinting fabric (14) is provided for pre-imprinting and for fixing strength.

74. The apparatus in accordance with any one of the preceding claims, characterized in that at least the first pressure field (I) is produced by means of at least one suction element (16) arranged at the side of the imprinting fabric (14) remote from the fiber web (12) to suck the fiber web (12) into the surface structure of the imprinting fabric (14).

75. The apparatus in accordance with claim 74, characterized in that a wet suction box is provided as the suction element (14).

76. The apparatus in accordance with any one of the preceding claims, characterized in that the fiber web (12) is pressed gently in the second pressure field (II), i.e. preferably over an extended nip in the web running direction (L).

77. The apparatus in accordance with any one of the preceding claims, characterized in that the second pressure field (II) is produced by means of a press nip (18).

78. The apparatus in accordance with claim 77, characterized in that the press nip (18) forming the second pressure field (II) is provided

between a dryer cylinder (20) and an opposing element (22), with the fiber web (12) guided through the press nip (18) being in contact with the surface (20') of the dryer cylinder (20) and contacting the imprinting fabric with its other side.

79. The apparatus in accordance with claim 78, characterized in that a Yankee cylinder is provided as the dryer cylinder (20).

80. The apparatus in accordance with claim 78 or claim 79, characterized in that a shoe press unit is provided as the opposing element (22) interacting with the dryer cylinder (20) and includes a flexible sleeve (26) guided via a press shoe (24) in the region of the press nip (18).

81. The apparatus in accordance with claim 80, characterized in that a shoe pressing roll provided with a flexible roll sleeve (26) is provided as the shoe press unit.

82. The apparatus in accordance with claim 78 or claim 79, characterized in that a suction press roll with a soft liner and/or a low pressing pressure is provided as the opposing element (22) interacting with the dryer cylinder (20).

83. The apparatus in accordance with claim 78 or claim 79, characterized in that a pressing roll or suction pressing roll is provided as the opposing element (22) interacting with the dryer cylinder (20).

84. The apparatus in accordance with any one of the preceding claims, characterized in that means are provided to dry the pre-imprinted

fiber web (12) on the dryer cylinder (20), to crepe the fiber web and/or to subsequently wind up the fiber web (12).

85. The apparatus in accordance with any one of the preceding claims, characterized in that the dry content at which the fiber web (12) is pre-imprinted and/or the dry content at which the three-dimensional surface structure is created, is in each case <30%, in particular <25%, in particular <15%, and preferably <10%.

86. The apparatus in accordance with any one of the preceding claims, characterized in that said third pressure field (III) is provided between said first pressure field (I) and said second pressure field (II).

87. The apparatus in accordance with any one of the preceding claims, characterized in that a drying apparatus is provided in order to provide said third pressure field (III).

88. The apparatus in accordance with claim 87, characterized in that said drying apparatus comprises a suction or pressure device (30).

89. The apparatus in accordance with any one of the preceding claims, characterized in that the fiber web (12) is guided together with an imprinting fabric (14) both through the third pressure field (III) and the second pressure field (II).

90. The apparatus in accordance with claim 88 or 89, characterized in that the suction device (30) has a curved surface and the fiber web (12) and the imprinting fabric (14) are guided over this curved surface.

91. The apparatus in accordance with claim 90, characterized in that a suction roll is provided as the suction device (30).

92. The apparatus in accordance with any one of the preceding claims, characterized in that said suction device (30) has a pressurized hood to support the vacuum effect of the suction device (30).

93. The apparatus in accordance with any one of the preceding claims, characterized in that a gas press, preferably an air press, is provided for providing said third pressure field (III).

94. The apparatus in accordance with claim 93, characterized in that said gas press comprises an arrangement of at least four rolls.

95. The apparatus in accordance with claim 93, characterized in that said gas press comprises a U-shaped box (82).

96. The apparatus in accordance with any one of the preceding claims, characterized in that the pressure in the chamber of said gas press is > 30 psi, preferably > 40 psi.

97. The apparatus in accordance with any one of the preceding claims, characterized in that the length of the press nip (18) of the shoe press including the dryer cylinder (20) and the shoe press unit (22) observed in the web running direction (L) is larger than a value of approximately 80 mm and the shoe press is designed such that a pressure profile results over the press nip length with a maximum pressing pressure which is smaller than or equal to a value of approximately 2.5 MPa.

98. The apparatus in accordance with any one of the preceding claims, characterized in that at least one dewatering fabric (42, 54) with zonally different fabric permeability is provided in the forming region.

99. The apparatus in accordance with claim 98, characterized in that a former with two circulating dewatering fabrics (14, 42) is provided, which run together while forming a pulp run-in gap (44) and are guided over a forming element (46) such as in particular a forming roll; and in that a dewatering fabric with zonally different fabric permeability is provided as an outer fabric (42) not coming into contact with the forming element (46) and/or as an inner fabric (54).

100. The apparatus in accordance with claim 99, characterized in that an imprinting fabric (14) is provided as the inner fabric and a dewatering fabric with zonally different fabric permeability is preferably provided as an outer fabric (42).

101. The apparatus in accordance with claim 99, characterized in that the fiber web (12) is preferably transferred from the inner fabric (54) to an imprinting fabric.

102. The apparatus in accordance with any one of the preceding claims, characterized in that an imprinting fabric (14), e.g. a TAD fabric or an imprinting membrane, is guided through the press nip (18) and is structured such that for this imprinting fabric (14) a smaller contact area portion formed by raised or closed zones (68) results in comparison with the non-contact area portion formed by recessed zones or holes, and a smaller contact area proportion of the fabric web (12) is correspondingly pressed in the press nip (18).

103. The apparatus in accordance with claim 102, characterized in that an imprinting fabric (14) is provided in which the contact area proportion of raised or closed zones (68) is ≤40% and preferably lies in a range from approximately 20% to approximately 30% and in particular at approximately 25%.

104. The apparatus in accordance with claim 102 or 103, characterized in that an imprinting fabric (14) is provided in which the raised zones (68) and the recessed zones result from offsets, i.e. from intersection points of picks and ends, of the fabric.

105. The apparatus in accordance with any one of the preceding claims, characterized in that at least one felt (36) with a foamed layer is provided for dewatering the web (12).

106. The apparatus in accordance with claim 105, characterized in that the foam coating is selected such that the mean pore size results in a range from approximately 3 to approximately 6 µm.

107. The apparatus in accordance with any one of claims 64 to 104, characterized in that a so-called SPECTRA membrane is provided for dewatering the web, with this SPECTRA membrane preferably being provided together with a conventional, in particular a woven, fabric, arranged between the SPECTRA membrane and for example a through flow cylinder.

108. The apparatus in accordance with any one of claims 64 to 104, characterized in that a so-called anti-rewetting membrane is provided for dewatering the web.

109. The apparatus in accordance with claim 108, characterized in that the anti-rewetting membrane is provided together with a conventional, in particular woven, fabric.

110. The apparatus in accordance with claim 108, characterized in that the anti-rewetting membrane is provided without an additional fabric or the like.

111. The apparatus in accordance with any one of the preceding claims, characterized in that a clothing (36), e.g. a fabric, a felt with a foamed layer, a SPECTRA membrane preferably together with a conventional, in particular a woven, fabric or an anti-rewetting membrane with or without a conventional, in particular woven, fabric, is guided together with an imprinting fabric (14) and a fiber web (12) interposed therebetween about a suction roll (38), with the clothing (36) preferably being in contact with the suction role (38).

112. The apparatus in accordance with any one of claims 105 to 111, characterized in that the clothing (36) with a foamed layer, a SPECTRA membrane preferably together with a conventional, in particular woven, fabric, or an anti-rewetting membrane with or without a conventional, in particular woven fabric, overcasts a suction roll (38) with a diameter of approximately 2 to approximately 3 m, or a plurality of suction rolls with smaller diameters, preferably two suction rolls with a diameter of, for example, approximately 2 m in each case.

113. The apparatus in accordance with any one of claims 105 to 111, characterized in that the suction roll (38) can have a vacuum applied to its underside.

114. The apparatus in accordance with any one of the preceding claims, characterized in that a vacuum is applied to the journal of the suction roll.

115. The apparatus in accordance with any one of claims 105 to 112, characterized in that a suction roll (38) with an associated siphon extractor is provided or the water is spun into a groove by centrifugal force.

116. The apparatus in accordance with any one of the preceding claims, characterized in that an air knife is provided for blowing off water.

117. The apparatus in accordance with any one of the preceding claims, characterized in that, to drive out water by means of gas pressure, e.g. air pressure, the fiber web (12) is guided together with an imprinting fabric (14) at least once and possibly twice through a pressure space (58) which is bounded by at least four rolls (60-66) arranged in parallel and into which a compressed gas can be led.

118. The apparatus in accordance with any one of the preceding claims, characterized in that the fiber web (12) is guided together with the imprinting fabric (14) and between membranes (72, 36) through the pressure space (58), with preferably an air distribution membrane (72) and an anti-rewetting membrane (36) being provided.

119. The apparatus in accordance with any one of the preceding claims, characterized in that the thickness of the imprinting membrane amounts to approximately 1 to approximately 3 mm.

120. An apparatus (10) for manufacturing a fiber web (12), in particular a web or tissue of hygiene material, in particular in accordance with any one of the preceding claims, comprising a displacement dewatering device for driving water out of said fiber web (12) and a clothing arrangement including, as regarded in the direction of the displacement fluid flow, the following elements: a membrane, an imprinting fabric, said fiber web (12), and an anti-rewet fabric; with said clothing arrangement preferably being followed, in the direction of the displacement fluid flow, by an e.g. vented roll with an open surface.

121. The apparatus in accordance with claim 120, characterized in that suction means are associated with said counter means.

122. The apparatus in accordance with claim 120 or 121, characterized in that said counter means comprises a vented roll.

123. The apparatus in accordance with claim 120 or 121, characterized in that said counter means comprises on open box.

124. The apparatus in accordance with any one of the claims 120 or 121, characterized in that a fabric is associated with the open surface of said counter means in order to provide a fluid distribution effect.

125. The apparatus in accordance with any one of the preceding claims 109 to 111, characterized in that aid anti-rewet fabric includes at

least one fluid or air distribution fabric layer, said distribution fabric layer being configured for contacting the open surface of said counter means.

126. The apparatus in accordance with any one of the preceding claims, characterized in that said anti-rewet fabric comprises at least one air distribution fabric layer and a perforated film layer and/or a spectra membrane, at least said perforated film layer being comprised of one of a polymeric or polyester film and a plastic film.

127. The apparatus in accordance with claim 126, characterized in that said anti-rewet fabric comprises more than two layers.

128. The apparatus in accordance with claim 127, characterized in that said anti-rewet fabric comprises a third backside layer that is very coarse.

129. The apparatus in accordance with claim 127, characterized in that said anti-rewet fabric comprises a backside air distribution fabric layer.

130. The apparatus in accordance with any one of the preceding claims, characterized in that said anti-rewet fabric comprises a multi layer structure as follows: air distribution layer/perforated film layer and/or SPECTRA membrane/air distribution/perforated film layer and/or SPECTRA membrane.

131. The apparatus in accordance with claim 130, characterized in that said anti-rewet fabric comprises a final backside water holding air distribution layer.

132. The apparatus in accordance with any one of the preceding claims, characterized in that said perforated film layer comprises a polymeric or polyester film coated with adhesive on one or both sides and holes put through both the polymeric or polyester film and the adhesive.

133. The apparatus in accordance with any one of the preceding claims, characterized in that each said air distribution fabric layer includes one of a plain weave and a multi-float weave.

134. The apparatus in accordance with claim 133, characterized in that each said air distribution fabric layer includes a multi-float weave.

135. The apparatus in accordance with any one of the preceding claims, characterized in that said perforated film layer has a series of perforate holes therein, each set of most-closely spaced perforate holes being separated by a perforate distance, each said air distribution fabric layer having a fabric weave associated therewith, said fabric weave having a weave repeat distance, said weave repeat distance being one of equal to and greater than said perforate distance.

136. The apparatus in accordance with claim 135, characterized in that said weave repeat distance is greater than said perforate distance.

137. The apparatus in accordance with any one of the preceding claims, characterized in that said perforated film layer has a series of perforate holes therein, said perforated film layer having about at least 40.000 holes/m^2.

138. The apparatus in accordance with claim 137, characterized in that said perforated film layer has a series of perforate holes therein, said perforated film layer having about at least 200.000 holes/m^2.

139. The apparatus in accordance with any one of the preceding claims, characterized in that said perforated film layer or SPECTRA membrane has an open area in the approximate range of 1 % to 30 %.

140. The apparatus in accordance with claim 138, characterized in that said perforated film layer or SPECTRA membrane has an open area in the approximate range of 5 % to 15 %.

141. The apparatus in accordance with any one of the preceding claims, characterized in that said perforated film layer or SPECTRA membrane has a thickness of less than about 0,04 inches.

142. The apparatus in accordance with claim 141, characterized in that said perforated film layer or SPECTRA membrane has a thickness of less than about 0,005 inches.

143. The apparatus in accordance with any one of the preceding claims, characterized in that each air distribution fabric layer is made of a sateen fabric.

144. An apparatus for dewatering a fiber web, in particular a web of tissue or hygiene material, characterized in that, to drive out water by means of gas pressure, the fiber web (12) is guided together with an imprinting fabric (14) at least once, and possibly twice, through a pressure space (58) which is bounded by e.g. at least four rolls (60-66) arranged in parallel and into which a compressed gas can

be led and in that the fiber web (12) is guided together with the imprinting fabric (14) between membranes (72, 36) through the pressure space, with preferably an air distribution membrane (72) and an anti-rewetting membrane (36) being provided.

145. An apparatus in accordance with any one of the preceding claims, characterized in that instead of a molding membrane a non-molding membrane is used for manufacturing graphic paper.

Fig. 1

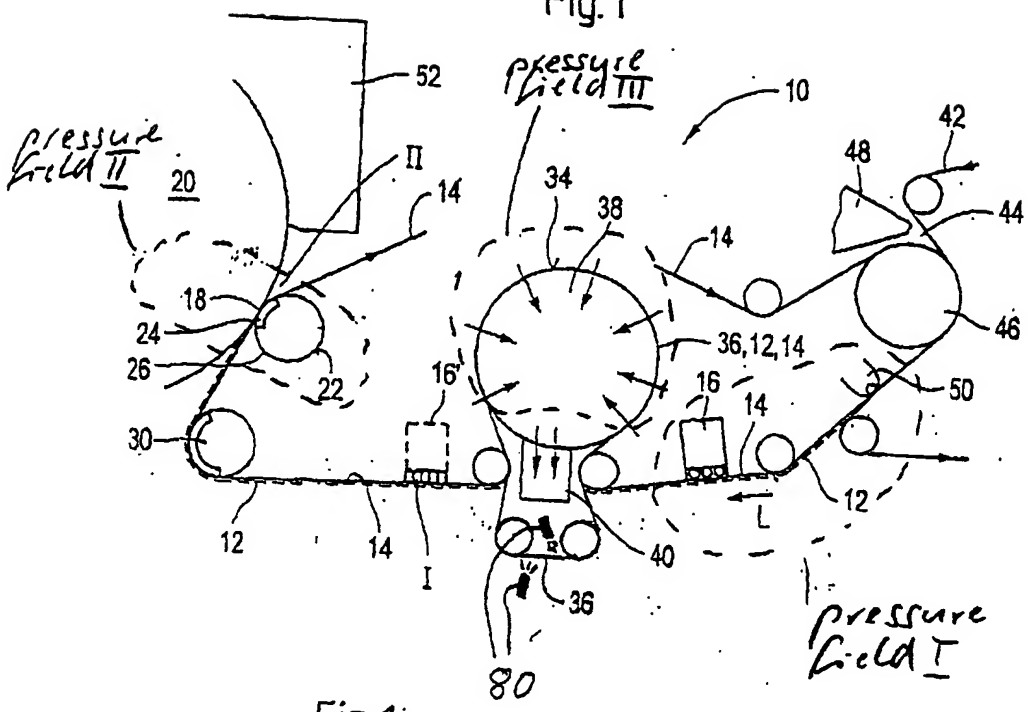

52
Pressure Field III
10
Pressure Field II
20
II
14
34
38
42
48
44
18
24
26
22
16
36,12,14
46
50
30
12
14
I
40
L
36
Pressure Field I
80

Fig. 1a

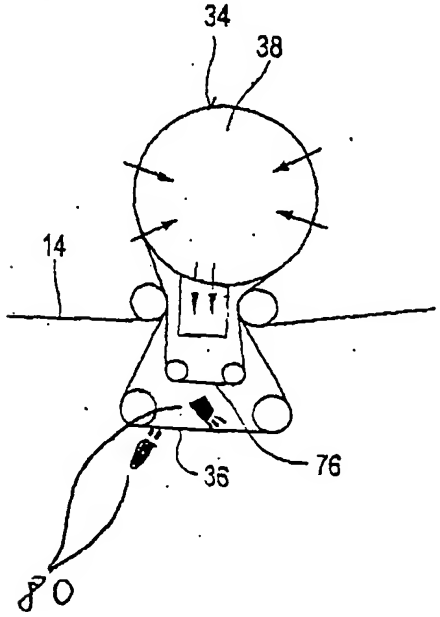
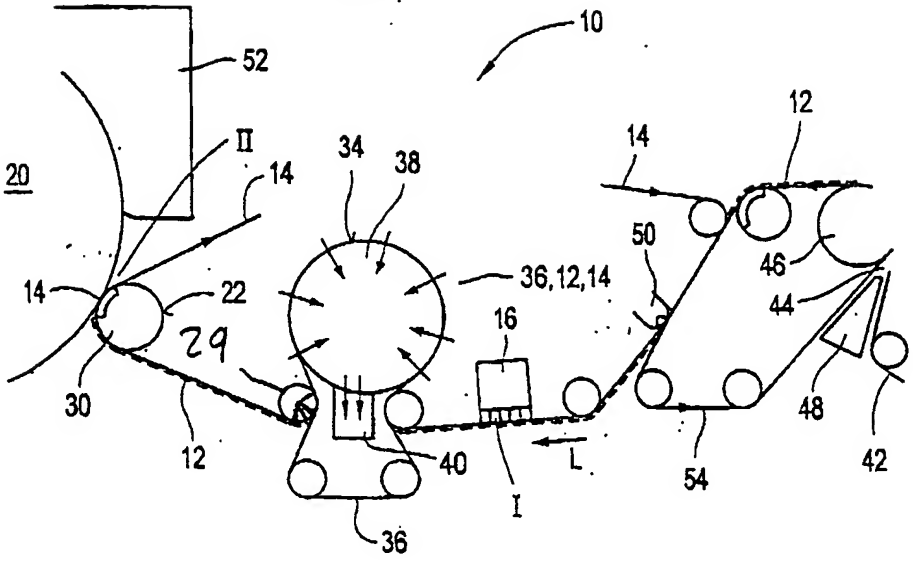

34
38
14
36
76
80

Fig.2


10
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II
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I
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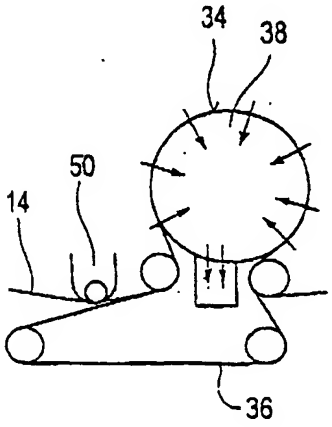
48
42
36

Fig.2a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38
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14
36

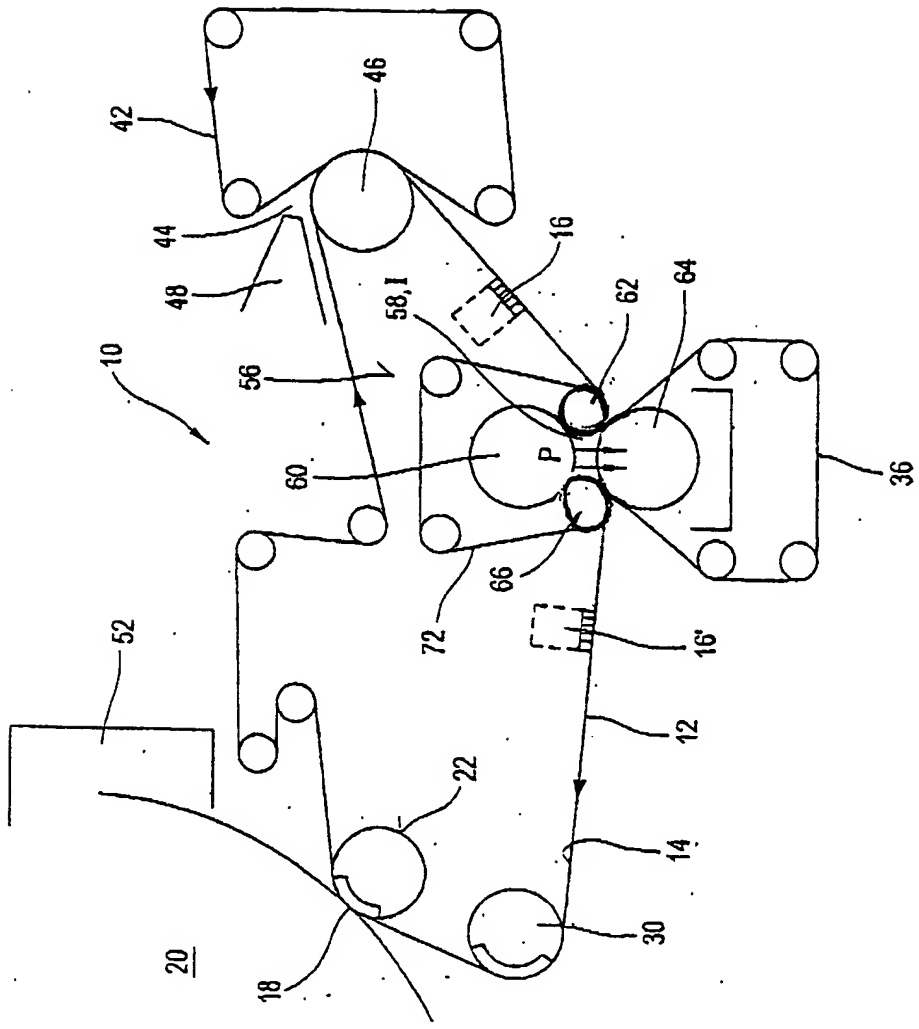


Fig.3

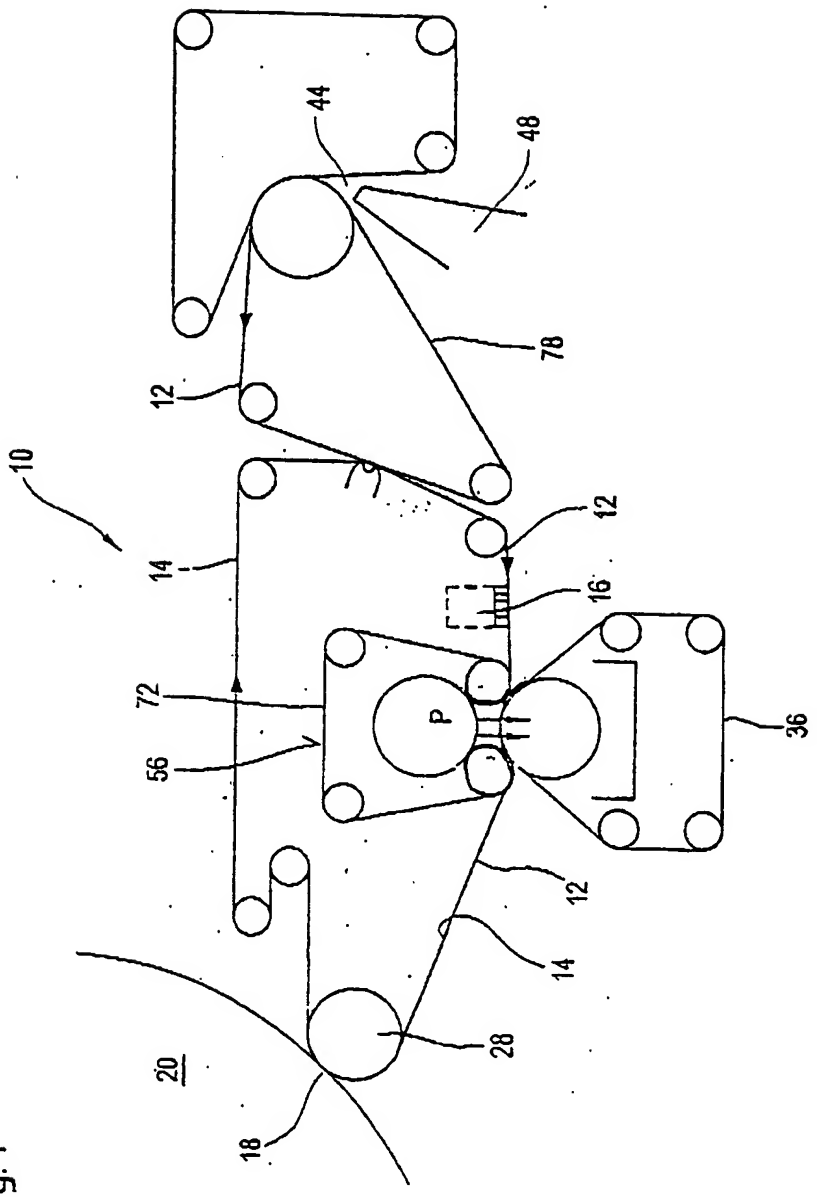


Fig.4

Fig. 5

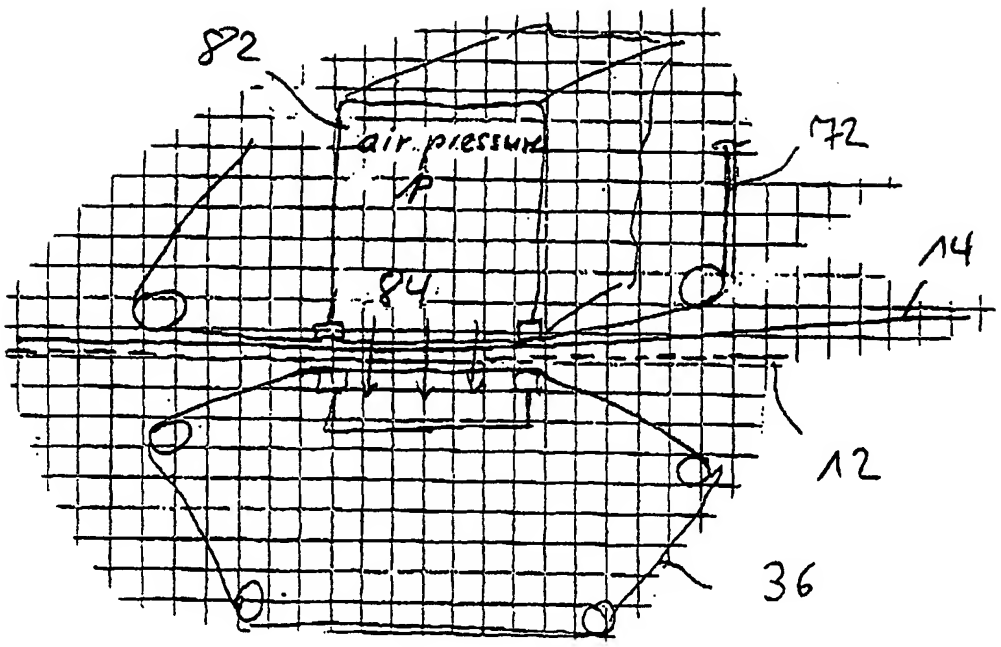


Fig. 6

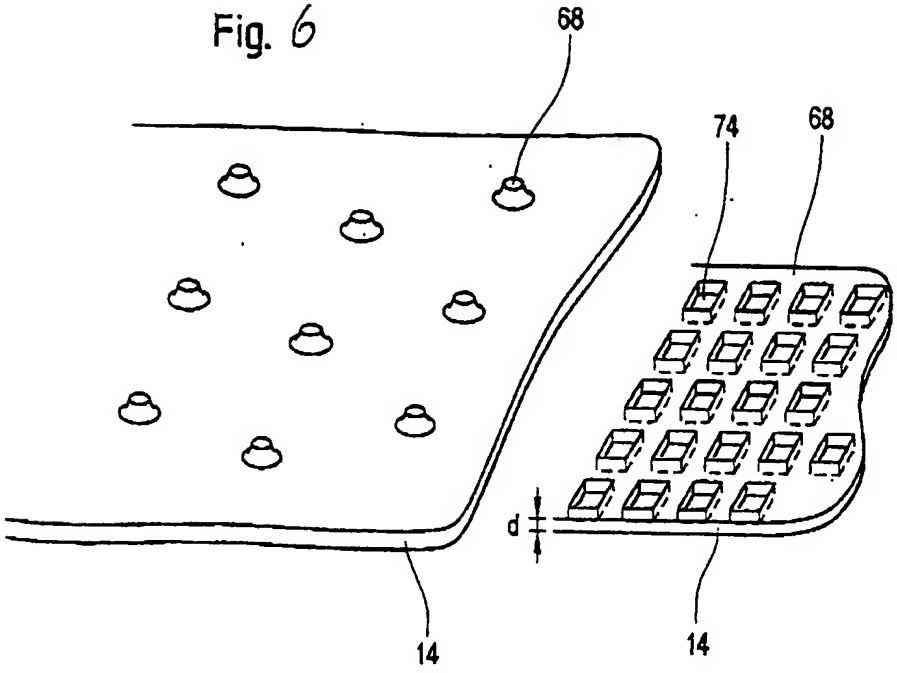


Fig. 7

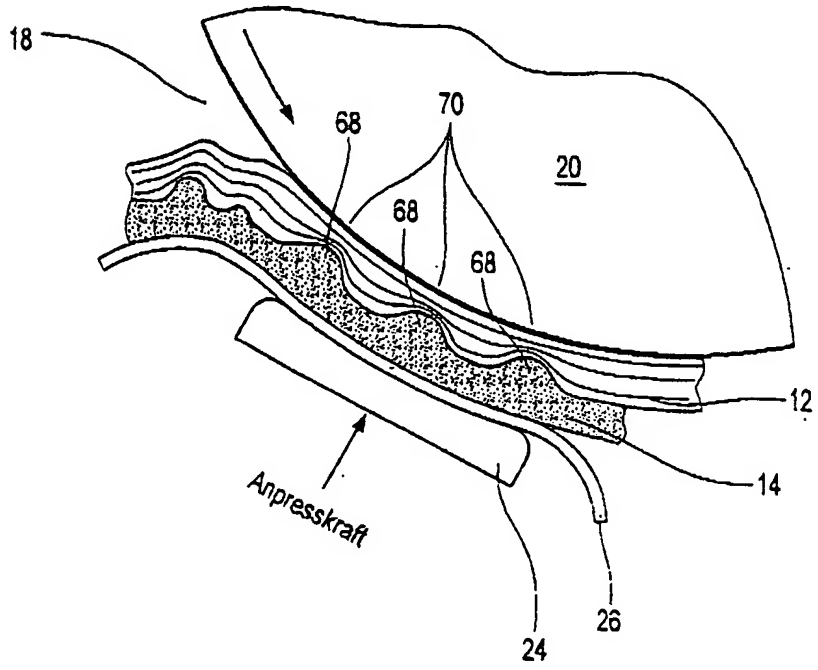


Fig. 8

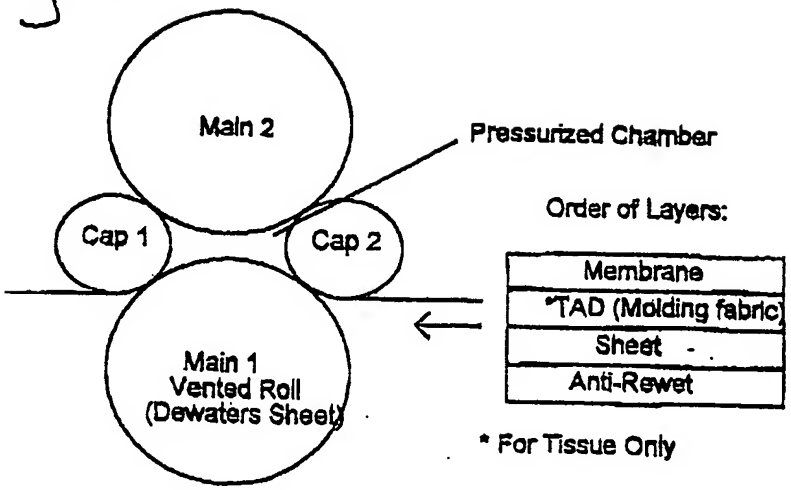


Fig. 9

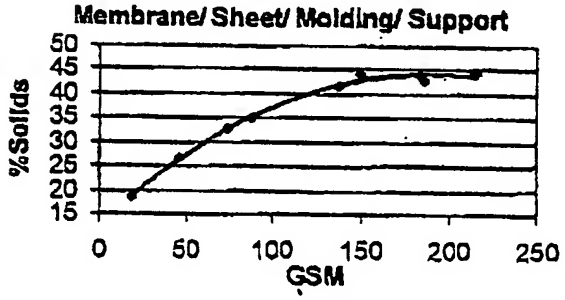


Fig. 10

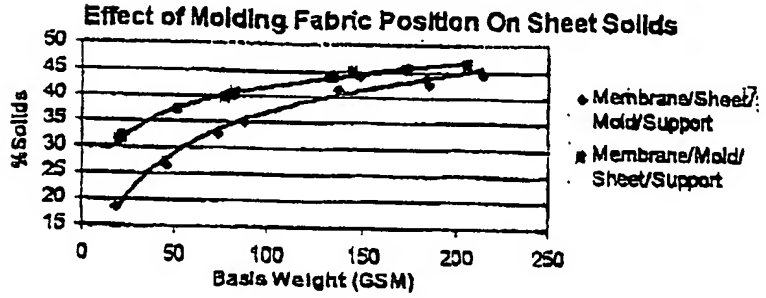


Fig. 11

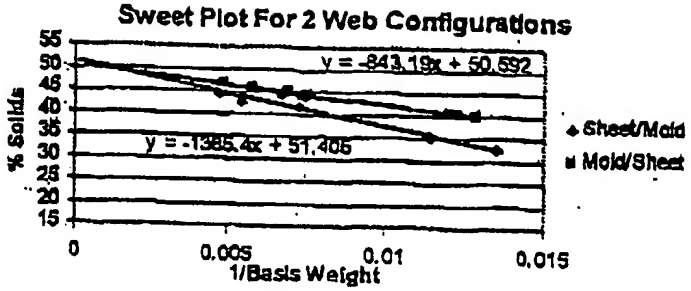


Fig. 12

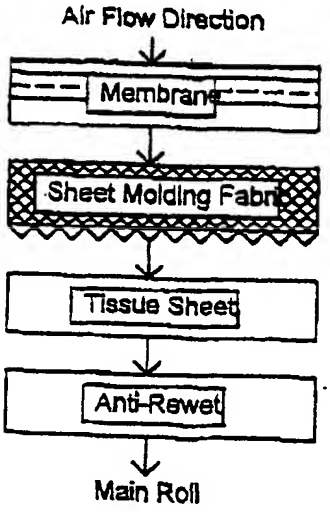


Fig. 13

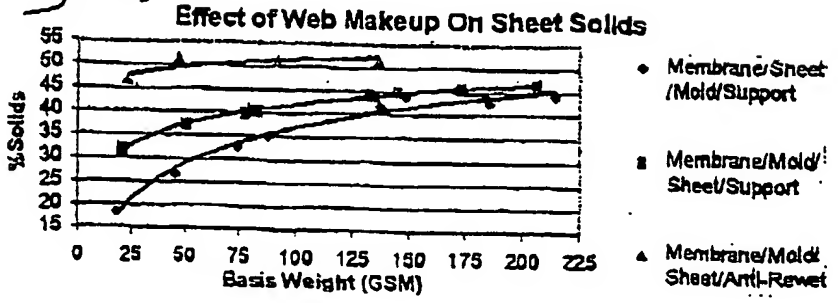


Fig. 14

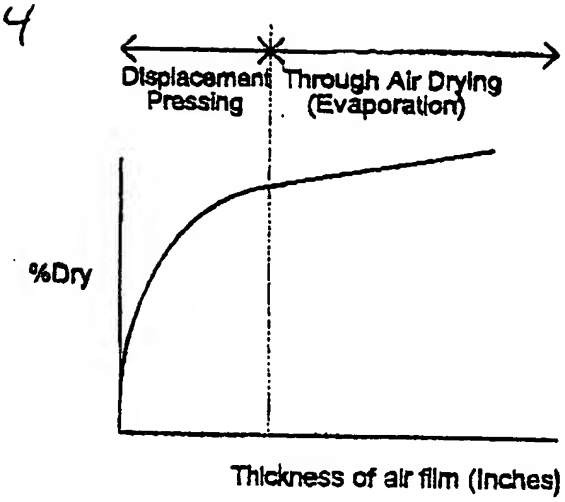
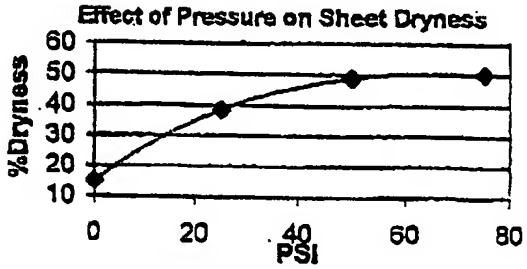

Displacement Pressing
Through Air Drying (Evaporation)
%Dry
Thickness of air film (Inches)

Fig. 15


Effect of Pressure on Sheet Dryness
%Dryness
60
50
40
30
20
10
0
20
40
60
80
PSI

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/02108

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : D21F 3/00, 11/00; F26B 13/06
US CL : 162/207, 358.1; 34/618
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 162/207, 358.1, 297, 363, 364; 34/618, 397, 398, 399, 453, 94, 143, 454, 459, 114

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PLUS SEARCH

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,051,105 A (AMPULSKI) 18 April 2000 (18.04.2000), column 6, lines 37-45, column 7, lines 59-63, see figure 1.	1-4, 64-67
A	US 4,356,059 A (HOSTETLER) 26 October 1982 (26.10.1982), see entire document.	1-4, 64-67
A	US 3,313,679 A (HINTERMAIER et al) 11 April 1967 (11.04.1967), see entire document.	1-4, 64-67
A, P	US 6,454,905 B1 (HOLLMARK et al) 24 September 2002 (24.09.2002), see entire document.	1-4, 64-67
A	US 5,492,598 A (HERMANS et al) 20 February 1996 (20.02.1996), see entire document.	1-4, 64-67
A	US 6,083,346 A (HERMANS et al) 04 July 2000 (04.07.2000), see entire document.	1-4, 64-67
A	US 5,510,002 A (HERMANS et al) 23 April 1996 (23.04.1996), see entire document.	1-4, 64-67
A	US 5,505,818 A (HERMANS et al) 09 April 1996 (09.04.1996), see entire document.	1-4, 64-67
A,E	US 6,533,900 B2 (PUUSTINEN et al) 18 March 2003 (18.03.2003), see entire document.	1-4, 64-67

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
26 April 2003 (26.04.2003)

Date of mailing of the international search report
29 MAY 2003

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Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

PCT/US03/02108

C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A, E	US 6,514,382 B1 (KAKIUCHI et al) 04 February 2003 (04.02.2003), see entire document.	1-4, 64-67

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/02108

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claim Nos.: 5-61, 63, 68-143
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.